Slide 1

Using Tracker for energy corrections of calorimeter objects

Olga Kodolova

Slide 2

CMS calibration program issues.

- HCAL calorimeter system will be calibrated before being situated inside detector:

- Calibration with radiactive sources will be performed for each tile before CMS operating, after closing and in mid−time on strong demand.

- Part of modules will be calibrated on test−beams with energies beginning from 25−30 GeV.

- Monitoring with laser will be performed all the time during the beam will be off.

No calibration for low−Pt pions, no influence of magnetic field, radiation and "mechanical" damages −> necessarity of off−line calibration and monitoring.

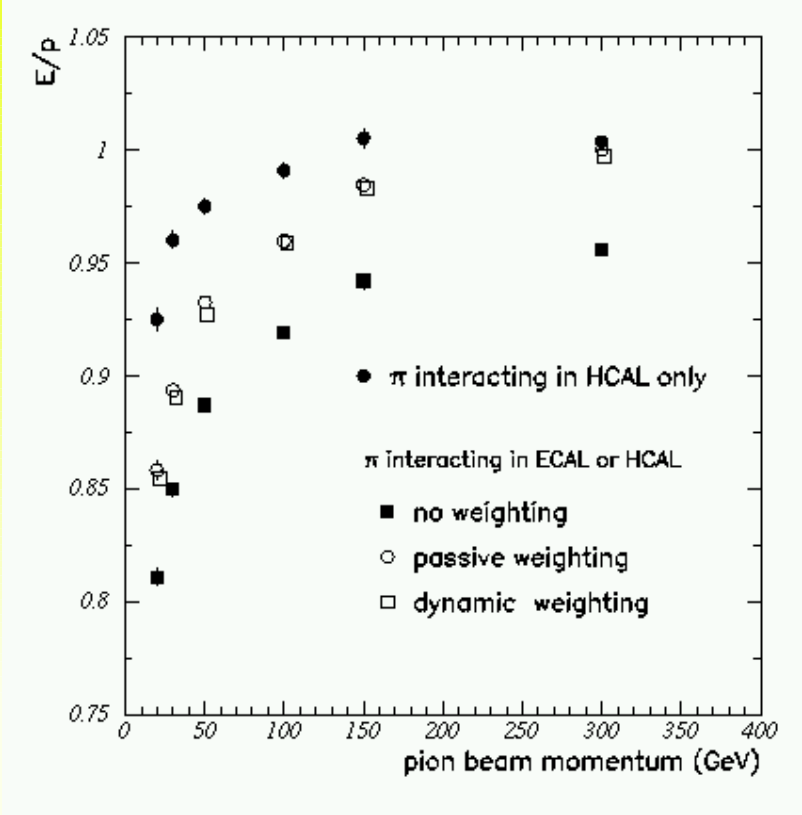
Slide 3

CMS calorimeters consists of two parts:

ECAL:
crystall of PbWO4
read out by APD

HCAL:
sampling calorimeter
absorber+scintillators

HF:
absorber+fibers



E/p for HCAL (1996 beam test)

Calorimeter response in both ECAL and HCAL is different for electrons and hadrons.

Non−linearity 15%

EM calibrated at EM scale

HAD had scale pions 50 GeV

Jet energy resolution
in cone 0.5 for |eta|<0.7

$$\frac{sigma}{E} = \frac{119}{\sqrt{E}} \circ 7$$

Slide 4

Jet reconstruction

Factors influent on jet energy resolution

From jet physics (from parton to jet on particle level):

- Fragmentation
- ISR and FSR
- Underlying event
- Minimum bias

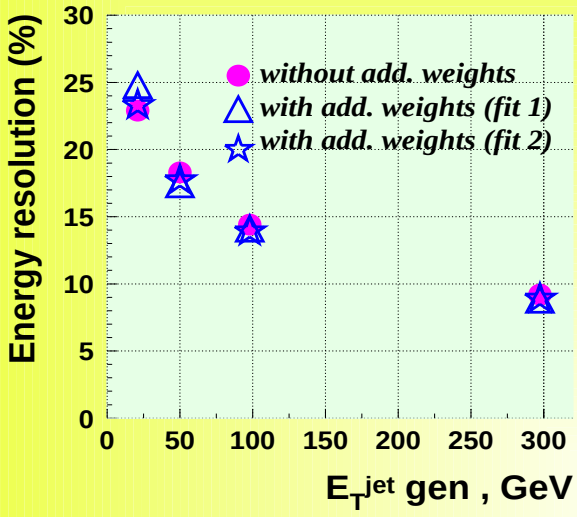
From detector performance:

- Electronic noise
- Magnetic field
- Different response of neutral and charged components (e/pi ratio)
- Shower size, out of cone loss, jet separations
- Dead materials and cracks
- Longatudinal leakage for high−Pt jets

Slide 5

Dependance of jet energy resolution on energy of jet. Jet algorithm with R=0.5

From talk I.Vardanian/O.Kodolova in March.



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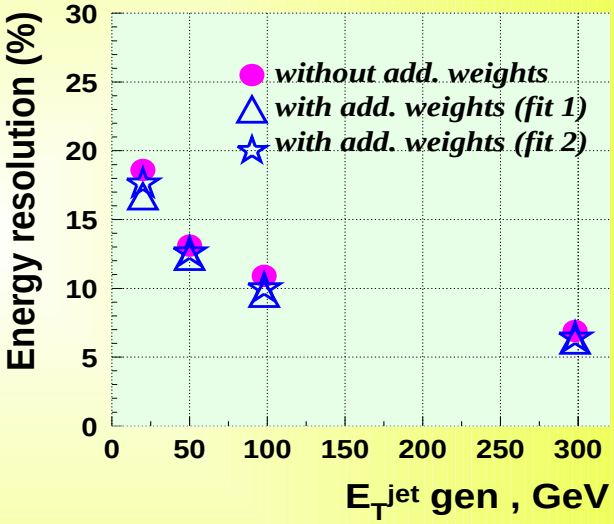

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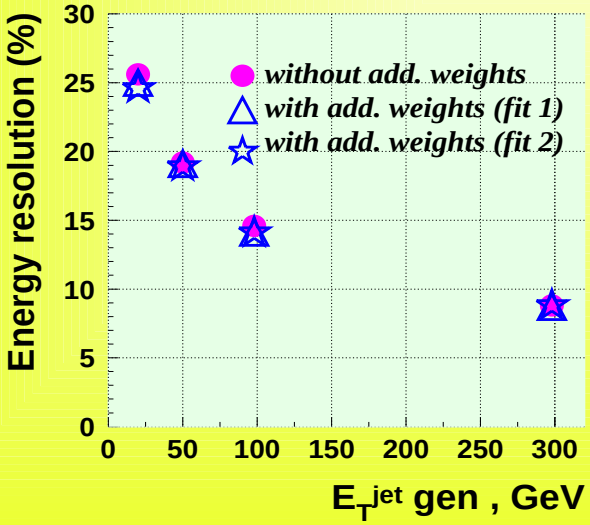
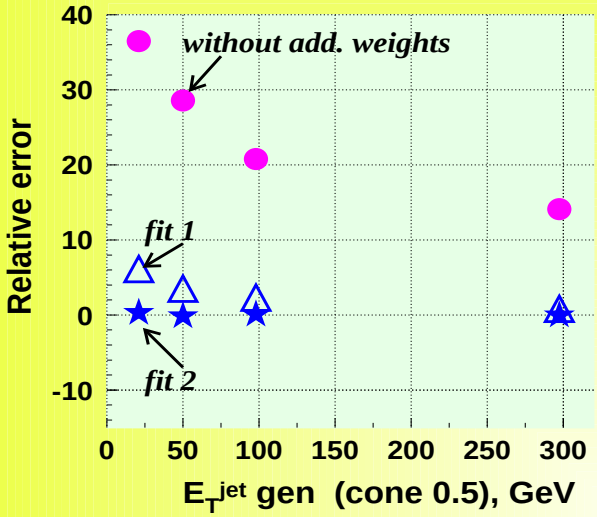


1.8<|eta|<2.1

Slide 6

Relative error with different weights on ECAL and HCAL readouts.



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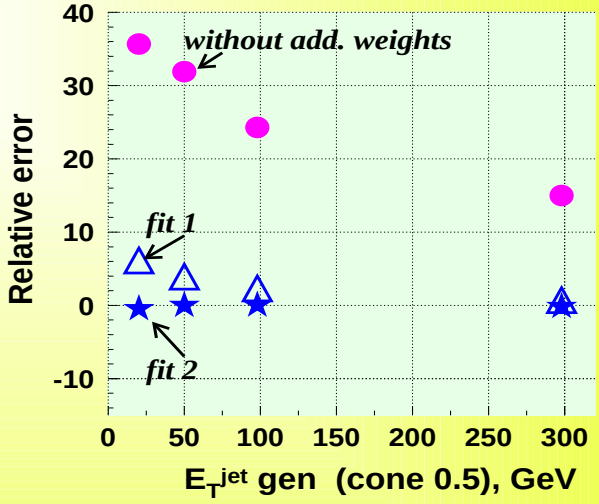
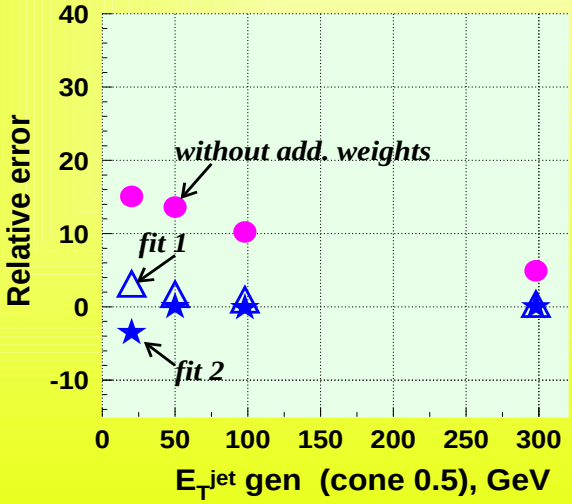
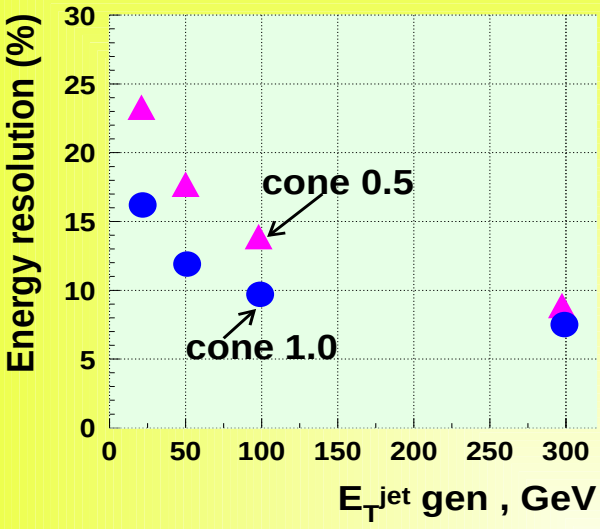




1.8<|eta|<2.1

Slide 7

Dependance of energy resolution on cone



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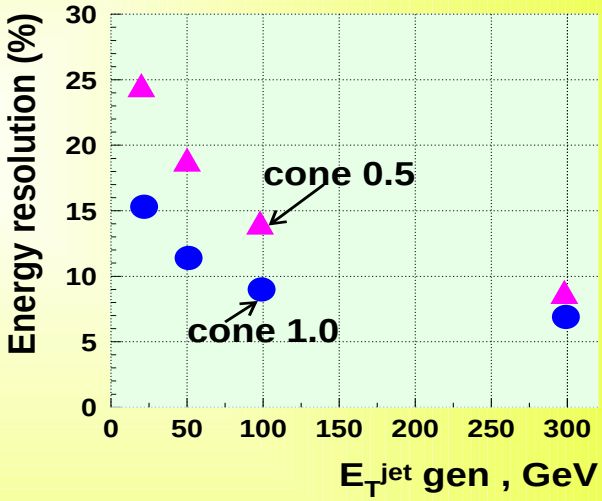
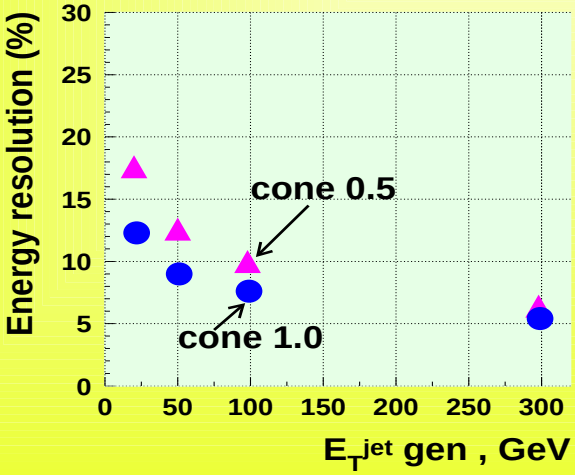
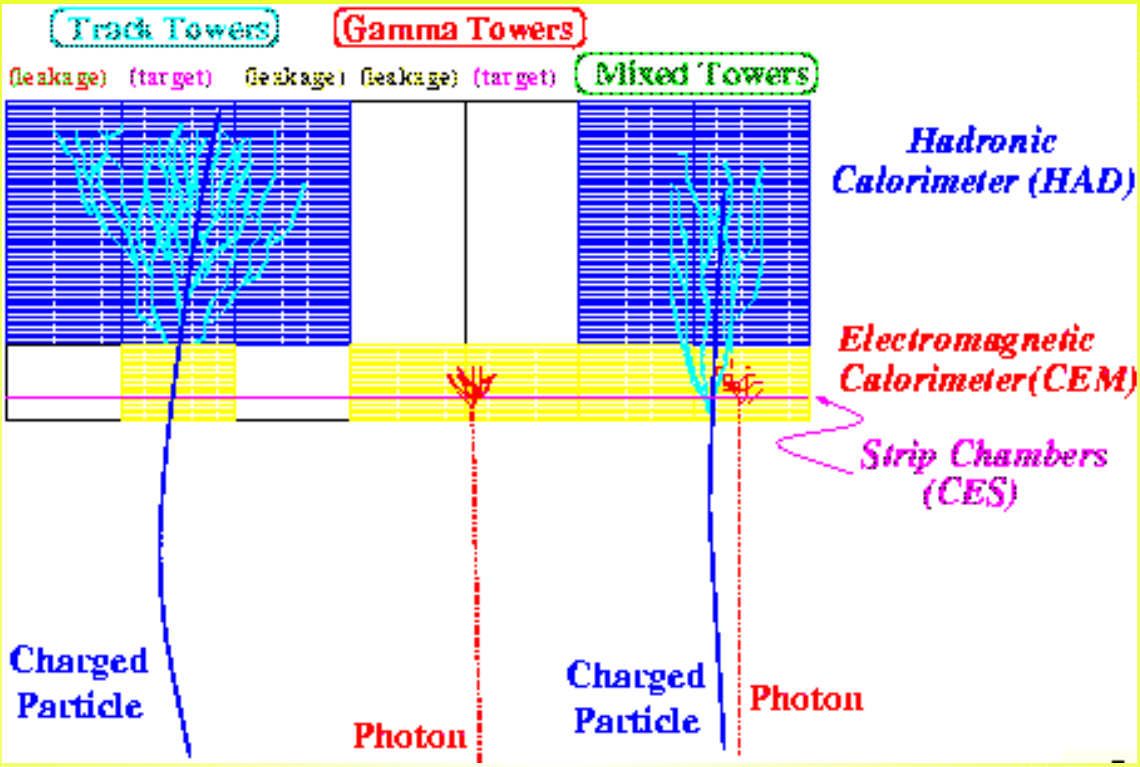




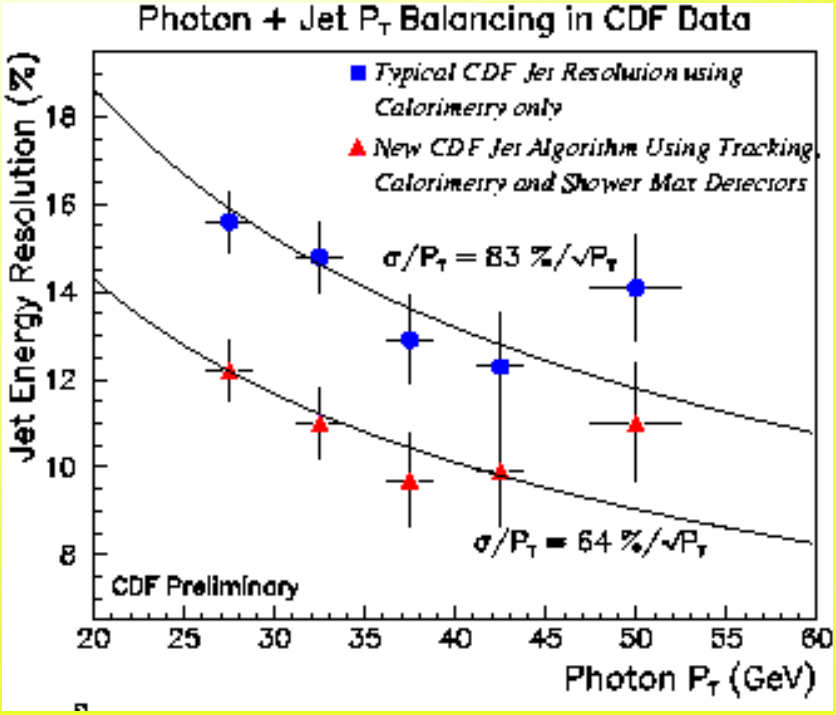
1.8<|eta|<2.1

Slide 8

CDF experience:



Track PT
EM Calorimeter
Combination:



$$ET = \sum P_T^{Trk} + (CEM - CEM_{Trk}) + k \cdot HAD$$

Slide 9

Dan Green, Calibration of CMS calorimeter, CMS NOTE − in preparation.

$E=E_e+E_h$, calorimeter response to the E: $\varepsilon=e*E_e+h*E_h$

Define: $F0=E_e/E$ − electromagnetic fraction.

For hadrons: F0=const * log(E)

For electrons: $\varepsilon_e=e*E$

For hadrons: $\varepsilon_h=E*h*(1+F0*(e/h-1))$

$\varepsilon_e/\varepsilon_h$ called e/pi=(e/h)/(1+F0*(e/h−1))

For electrons and photons: ε=E, if calibrate on electrons

Then: $E=\varepsilon_h*(e/pi)$

We need e/h both for ECAL and HCAL.

For HCAL it can be determined in situ and on test beams for hadrons not−interacting in ECAL (>30% of hadrons). From test beams for HCAL: e/h=1.39

$E=E_E+E_H$

$E=(e/pi)_E\varepsilon_E+(e/pi)_H\varepsilon_H$, $F0_H=0.11*\ln(\varepsilon_H)$

For ECAL more complicated: $(e/pi)=\{Ebeam-E_H\}/\varepsilon_e$

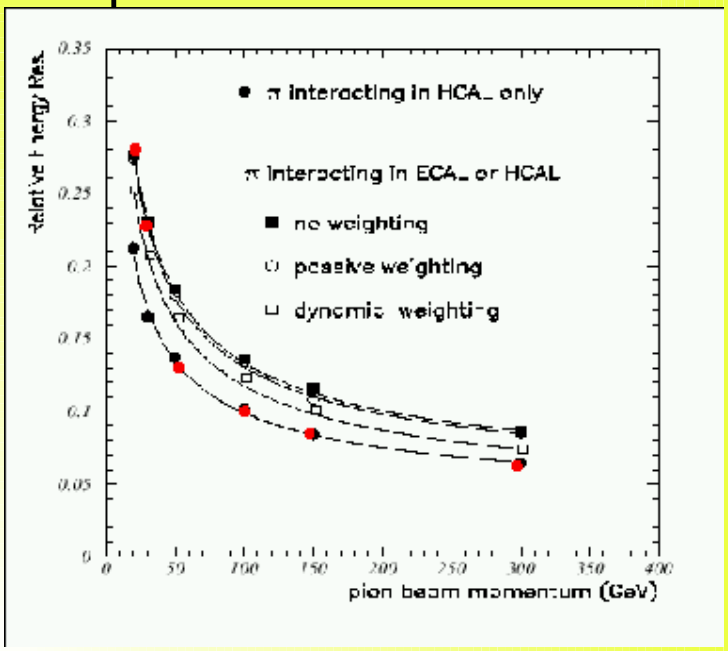
using events with large energy deposition in ECAL

Slide 10

First attempts for improving energy resolution using tracker in CMS

Dan Green: using procedure described above improves relative resolution for test−beam pions with PT>50 GeV/c

Relative energy resolution depending on the pion beam energy.
Red points−resolution with calibration technique given above.



Can we have enough isolated particles to determine e/pi ratio for ECAL and HCAL during data taking?

Pions from tau−>pi nu from W−>tau nu, Z−>tau tau were proposed to use for "in situ" calibration of HCAL

D.Denegri, R.Kinnunen, A.Nikitenko, CMS NOTE 1997/039

Pions from QCD jets were proposed to use for "in situ" calibration of HCAL for pions with P_T=15−70 GeV/c

R.Kinnunen, A.Nikitenko, CMS NOTE 1997/097

Slide 11

Proposal how to implement e/pi for jets (under work).

➔ With single or isolated particles with as low momentum as possible.

Find parametrization: E_E, E_H as F(E) of the charged.

Find $(e/h)_E$, $(e/h)_H$ using Dan's procedure

➔ Classify clusters in ECAL.

Propagate track from tracker to ECAL surface.

If there is a close cluster with E_{MIP} − non−intercating pion

If there is close cluster with E~Etrack−electron

If there is no close cluster or Ecluster does not coincide with previous two cases−interacted pion

➔ Recalculate jet energy

Find R_E, R_H for each recognized interacted charged

$R_E=E_E/(e/pi)_E$; $R_H=E_H/(e/pi)_H$,

R_k^E, R_k^H−response from neutral hadrons in ECAL and HCAL.

$$R_{e/g}+R_K^E=R_{ECAL}-\text{sum}(R_E)-\text{sum}(E_{MIP})$$

$$R_k^H=R_{HCAL}-\text{sum}(R_H)$$

$$E_{jet}=R_{e/g}+R_K^E+E_{tracker}+R_K^H \text{ x } (e/pi)_H$$